US009303763B2

(12) **United States Patent**
Yamaguchi et al.

(10) **Patent No.: US 9,303,763 B2**
(45) **Date of Patent: Apr. 5, 2016**

(54) **BICYCLE REAR DERAILLEUR**

(71) Applicant: **Shimano Inc.**, Sakai, Osaka (JP)

(72) Inventors: **Sota Yamaguchi**, Osaka (JP); **Satoshi Shahana**, Osaka (JP)

(73) Assignee: **Shimano, Inc**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 231 days.

(21) Appl. No.: **13/709,382**

(22) Filed: **Dec. 10, 2012**

(65) **Prior Publication Data**

US 2014/0162818 A1 Jun. 12, 2014

(51) **Int. Cl.**

F16H 63/00	(2006.01)
F16H 61/68	(2006.01)
B62M 9/1242	(2010.01)
B62M 9/122	(2010.01)
B62M 9/124	(2010.01)

(52) **U.S. Cl.**

CPC ***F16H 61/68*** (2013.01); ***B62M 9/122*** (2013.01); ***B62M 9/1242*** (2013.01); *B62M 2009/12406* (2013.01)

(58) **Field of Classification Search**

CPC B62M 25/08; B62M 9/122; B62M 9/132; B62M 9/121; B62M 9/123; B62M 9/124; B62M 9/1242; B62M 9/1246; B62M 2009/12406

USPC 474/70, 80, 82

See application file for complete search history.

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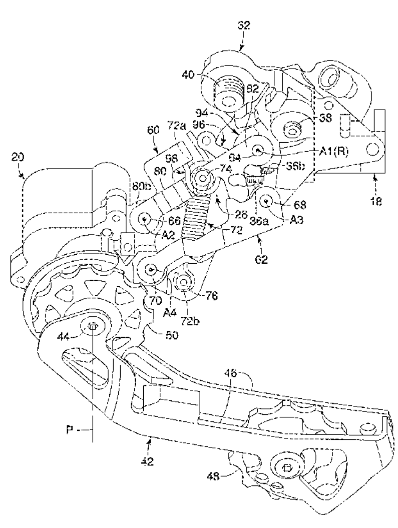
Primary Examiner — William E Dondero
Assistant Examiner — Minh Truong
(74) *Attorney, Agent, or Firm* — Global IP Counselors

(57) **ABSTRACT**

A bicycle rear derailleur includes a base member, a movable member, a linkage and a motor unit. The base member is configured to be mounted to a bicycle. The movable member is movably coupled to the base member. The linkage includes an outer link pivotally connected to the base member about a first pivot axis and pivotally connected to the movable member about a second pivot axis, and an inner link pivotally connected the base member and the movable member. The motor unit includes an output shaft having a rotational axis being parallel to one of the first pivot axis and the second pivot axis. The output shaft of the motor unit drives the outer link to move the movable member with respect to the base member. The inner link moves in response to movement of the outer link.

15 Claims, 10 Drawing Sheets



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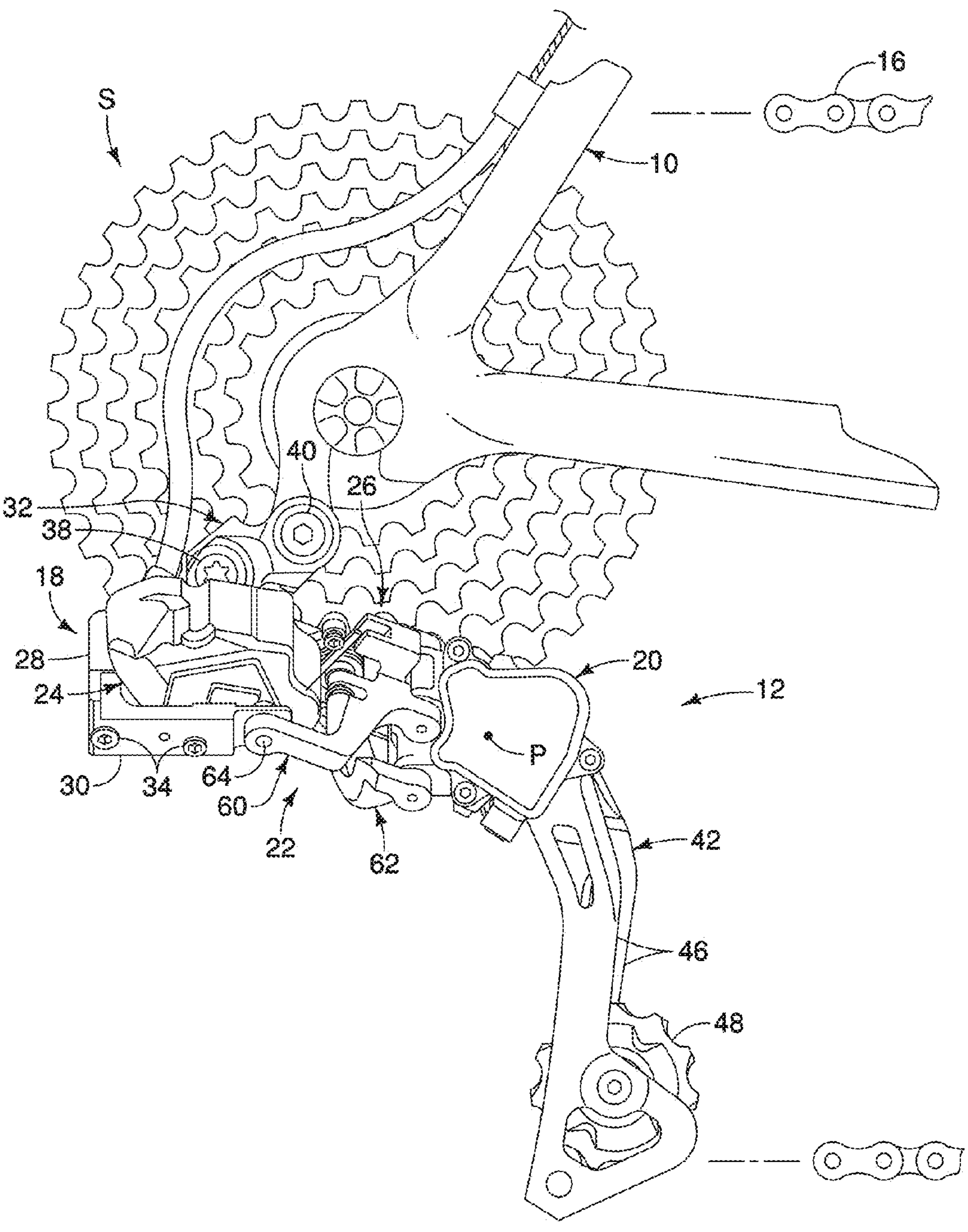
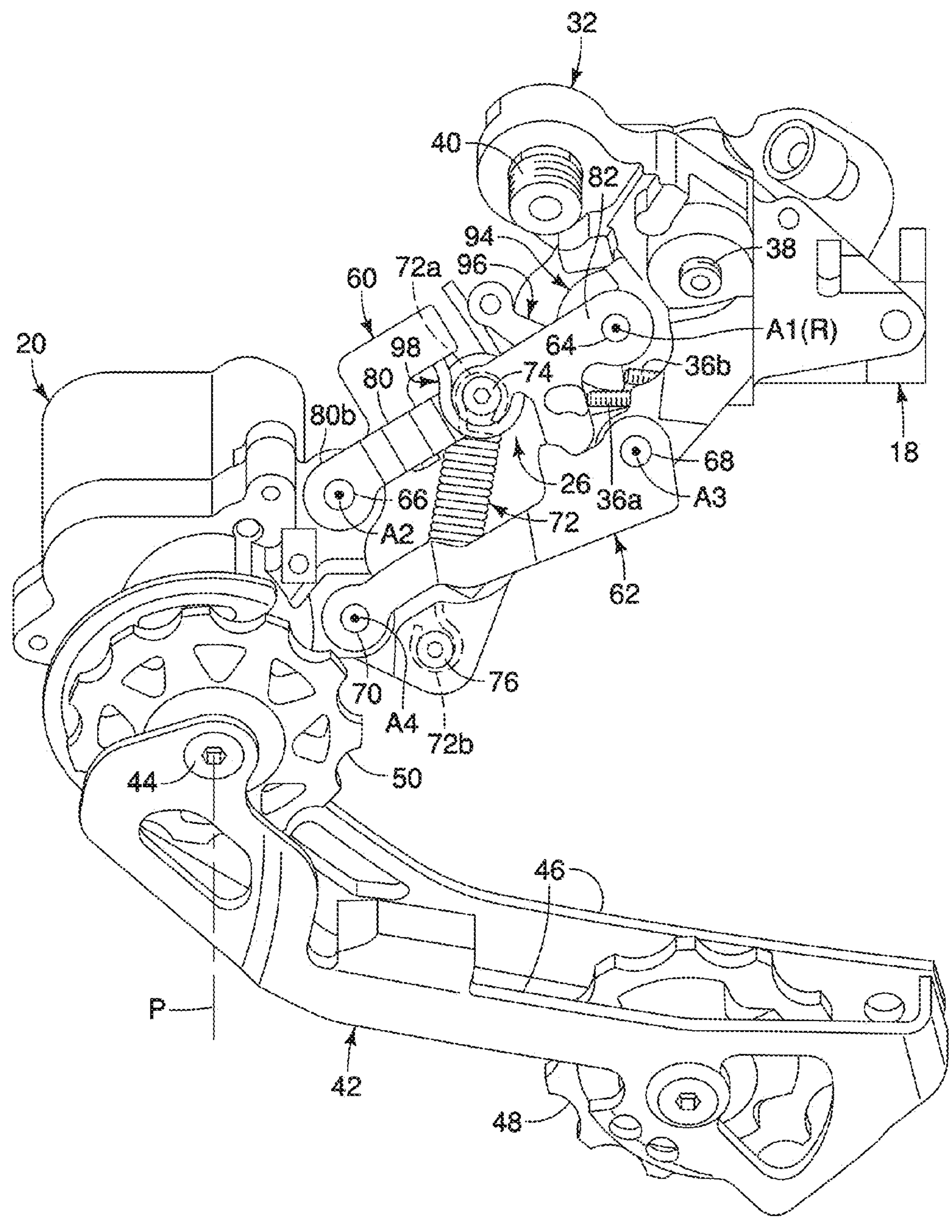


FIG. 1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64
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74
36b
80
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68
18
66
36a
A3
72
A2
62
70
76
A4
72b
44
50
46
P
42
48

FIG. 2

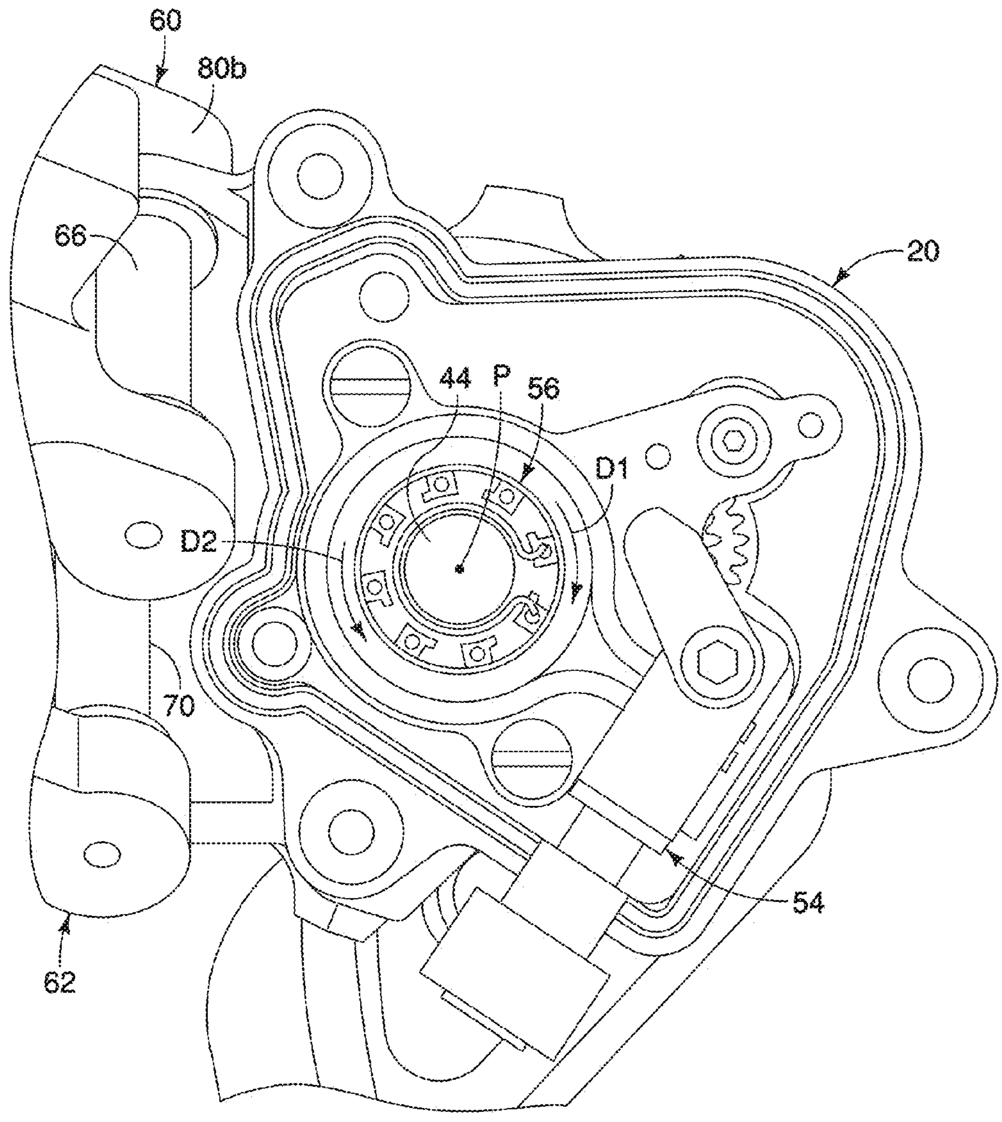


FIG. 3

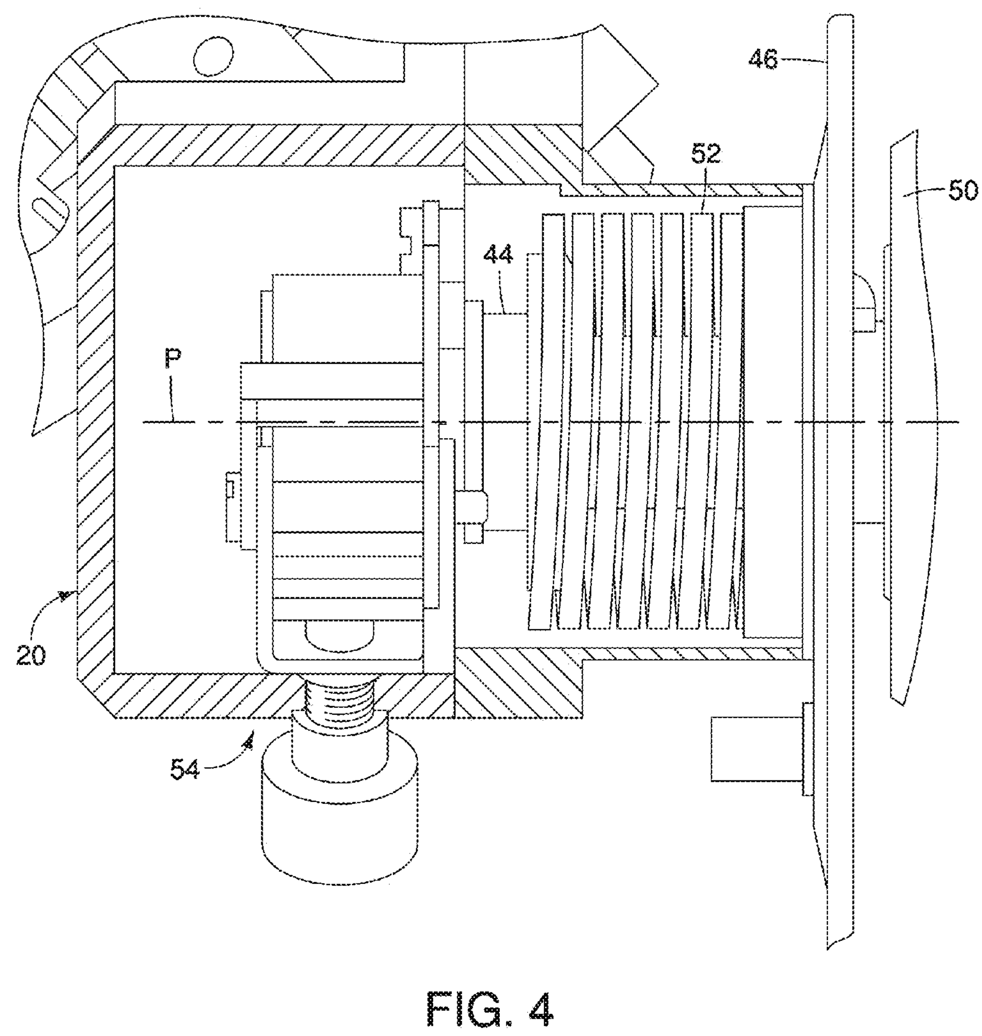
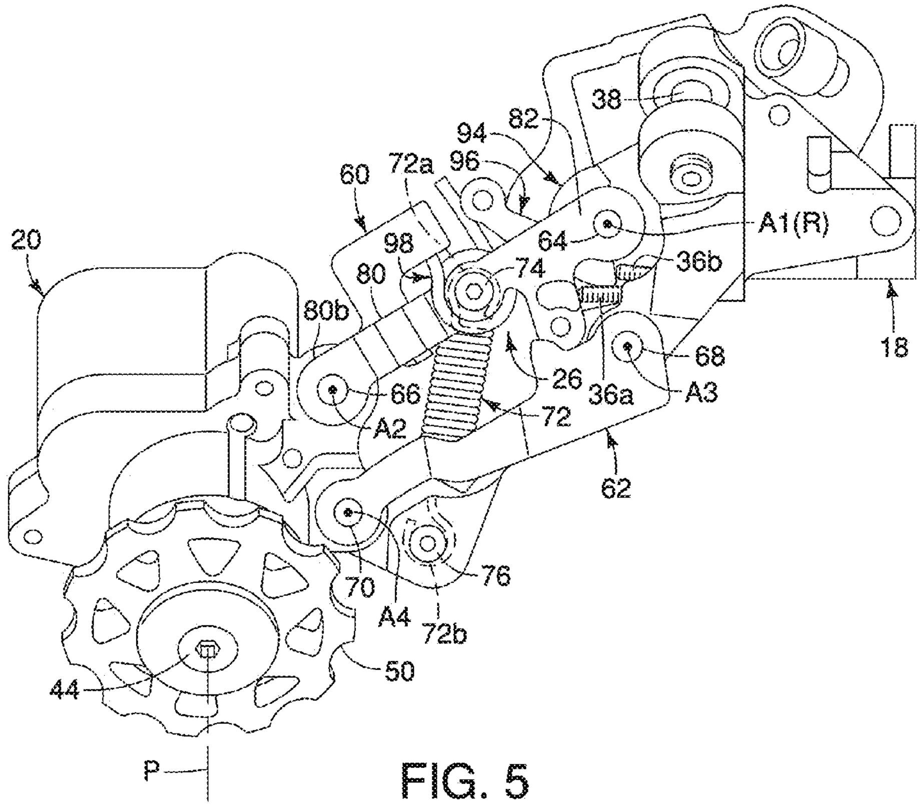


FIG. 4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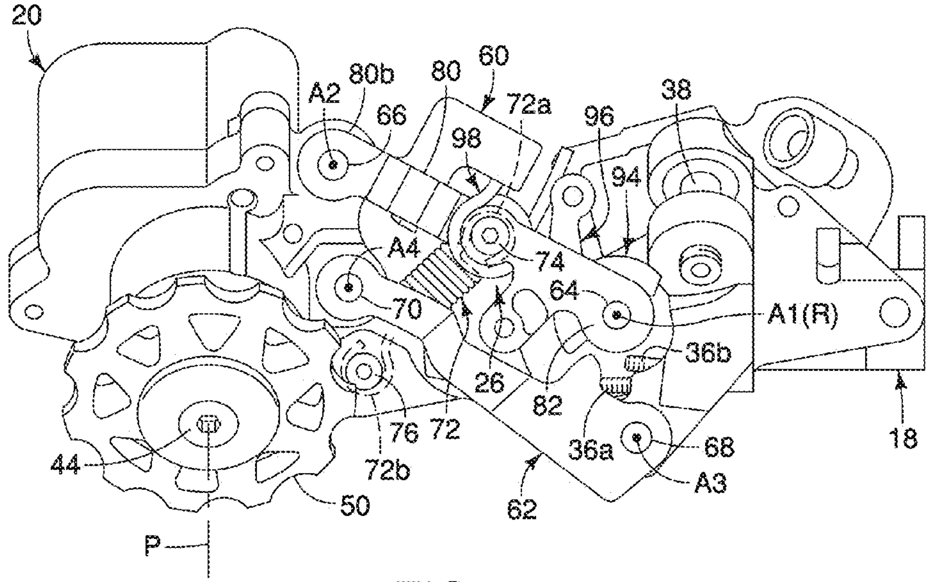
A2
72
A3
18
62
70
A4
72b
76
44
50
P

FIG. 5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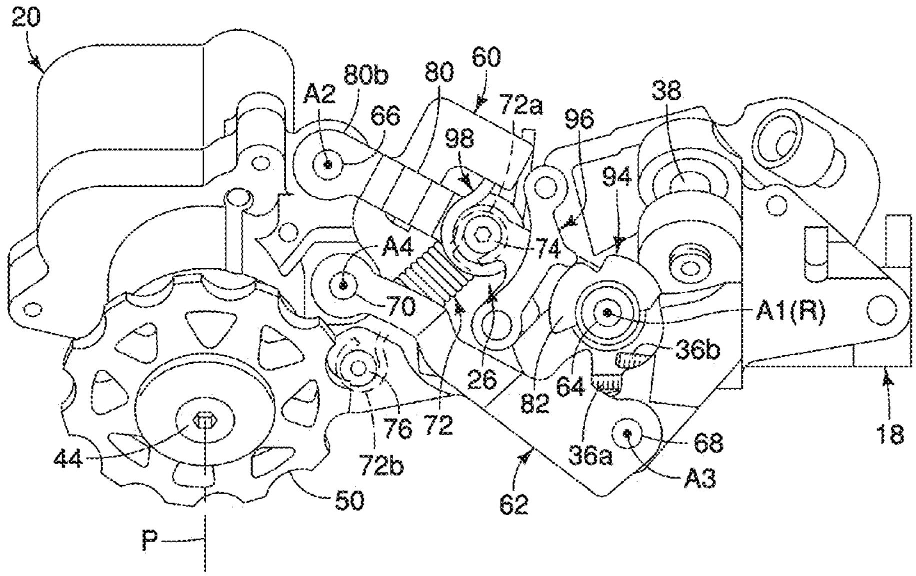
44
50
62
P

FIG. 6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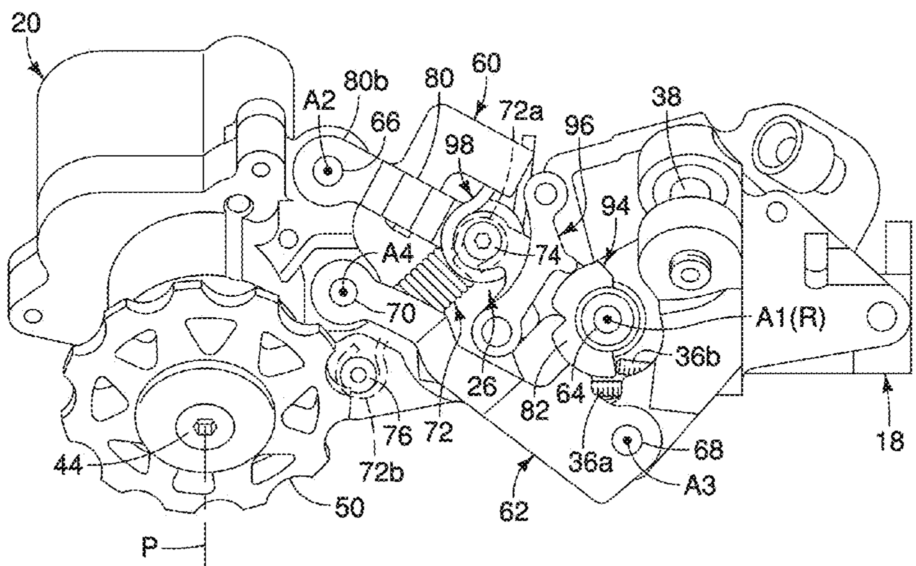
76
72
44
72b
36a
68
18
A3
50
62
P

FIG. 7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A4
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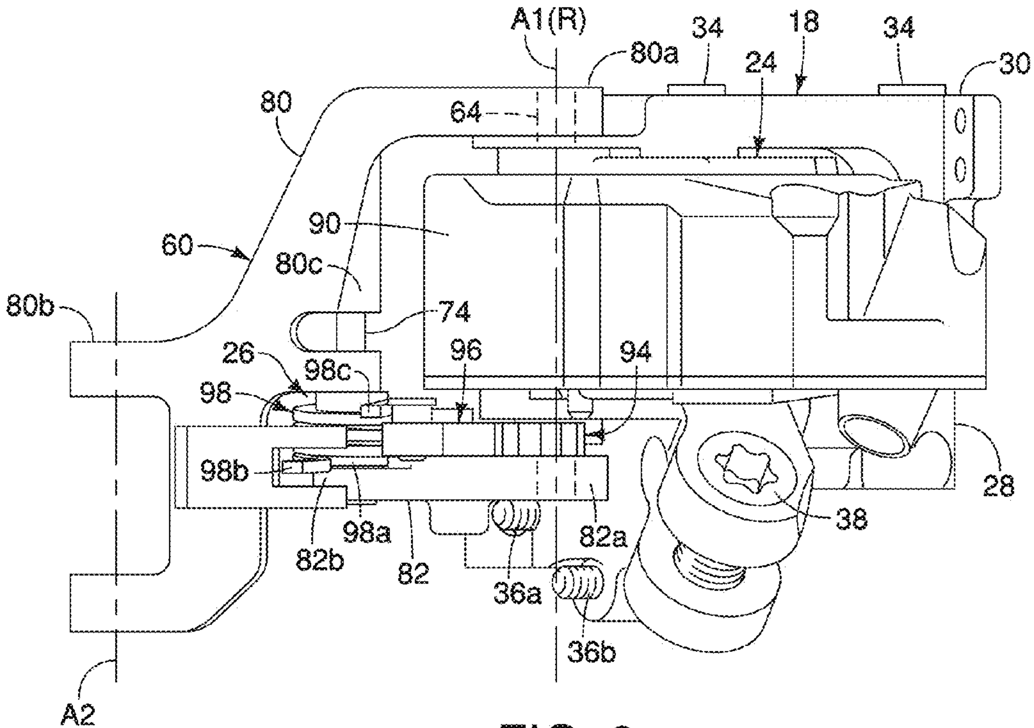
44
72b
36a
68
18
A3
50
62
P

FIG. 8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80c
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98b
28
38
82a
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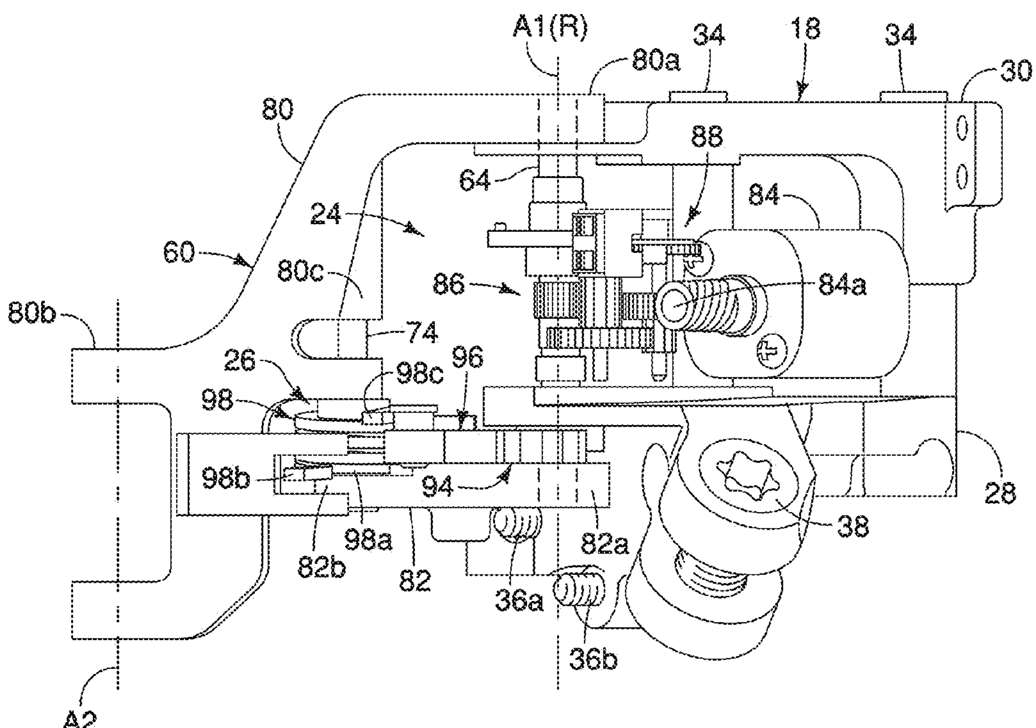
82b
82
36a
36b
A2

FIG. 9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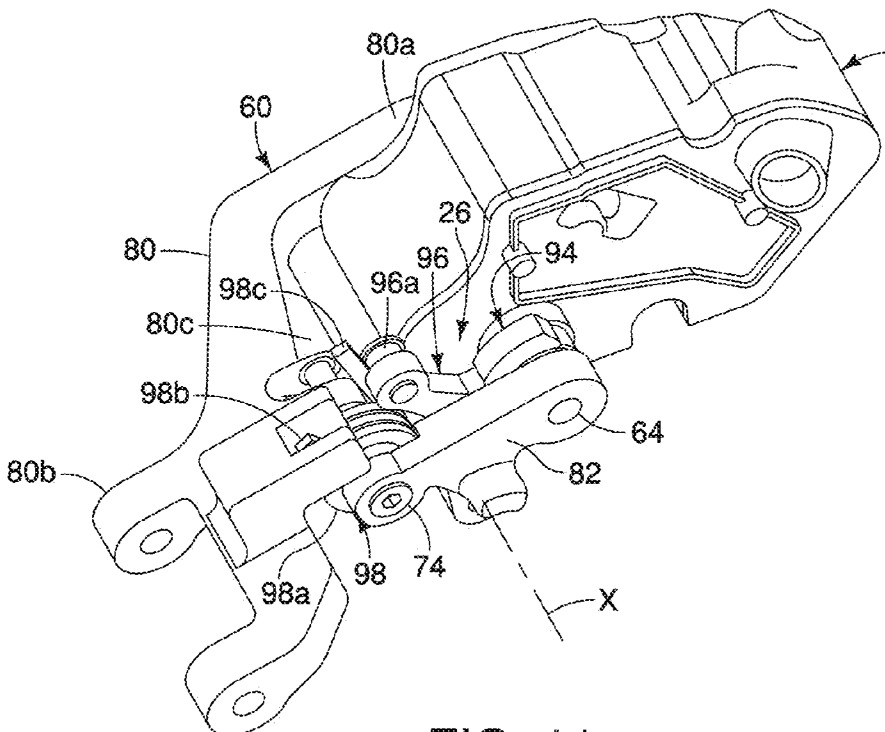
36a
36b
A2

FIG. 10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96a
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64
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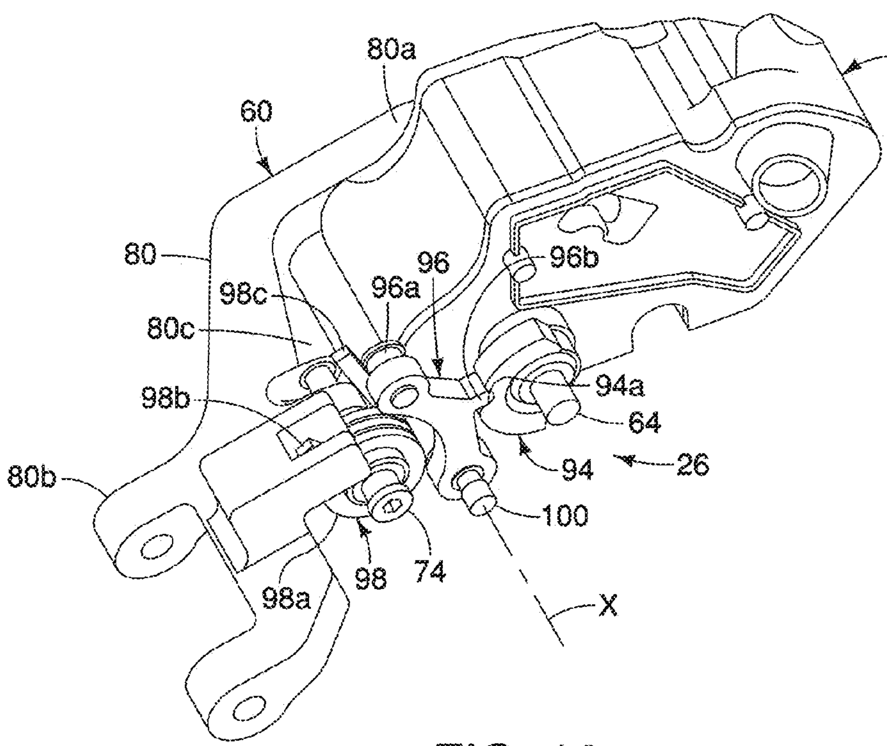
80b
74
98
98a
X

FIG. 11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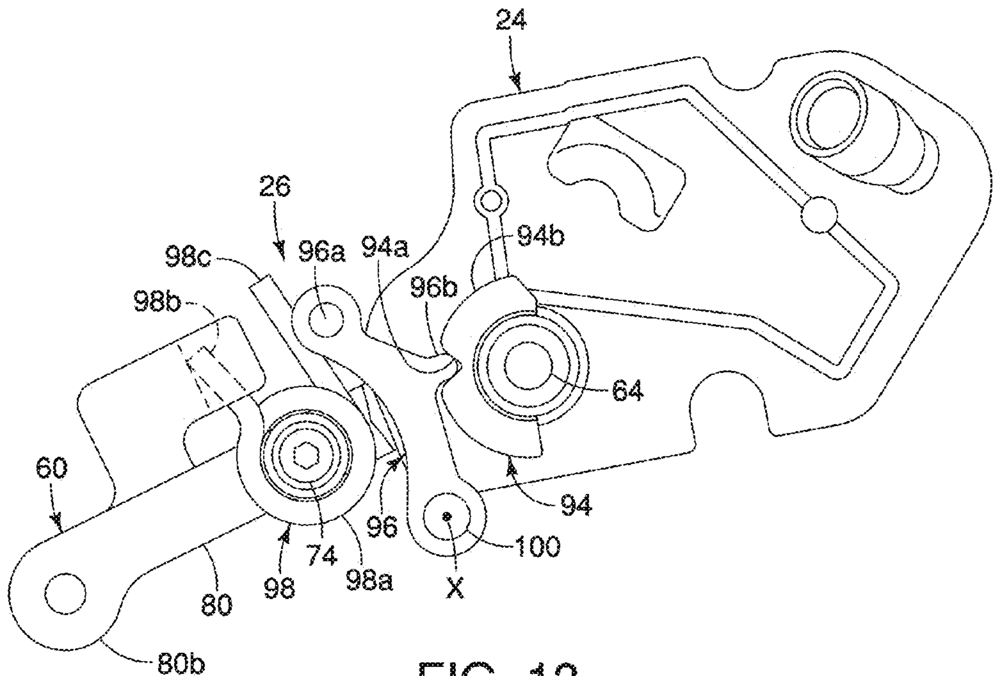
100
74
98
98a
X

FIG. 12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26
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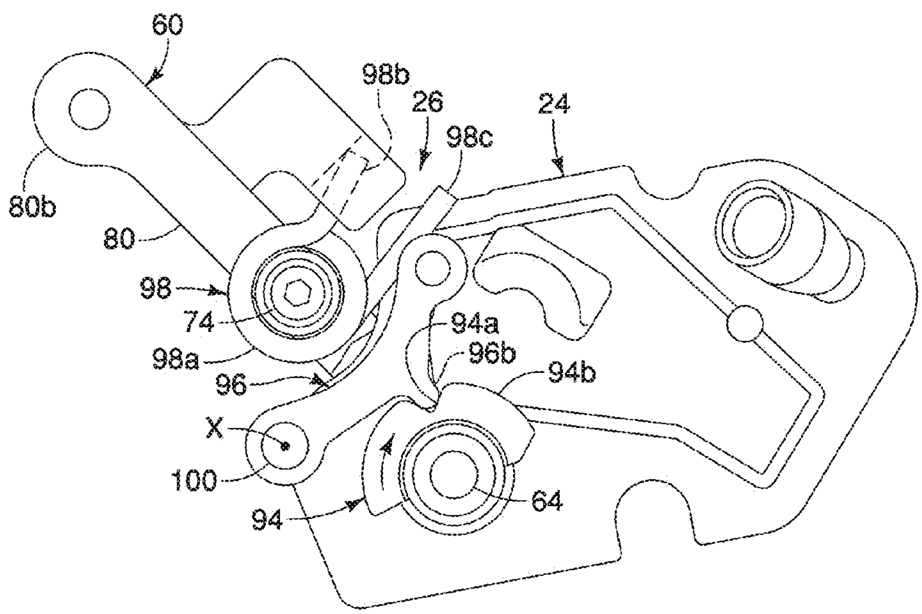
96b
64
60
94
96
74
100
98
98a
X
80
80b

FIG. 13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98b
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80
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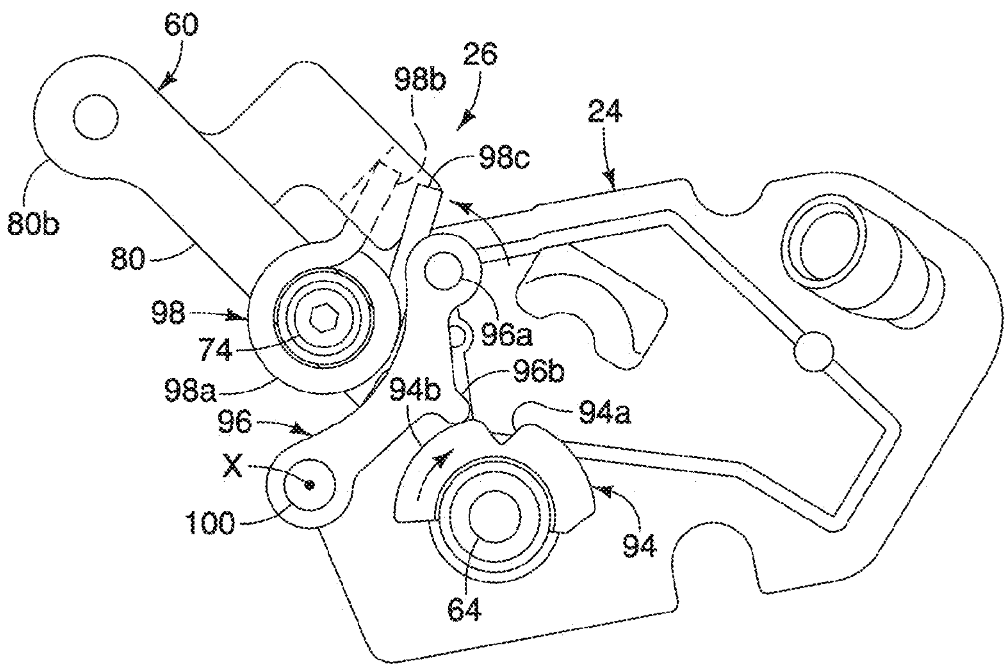
74
94a
96b
98a
94b
96
X
100
64
94

FIG. 14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94a
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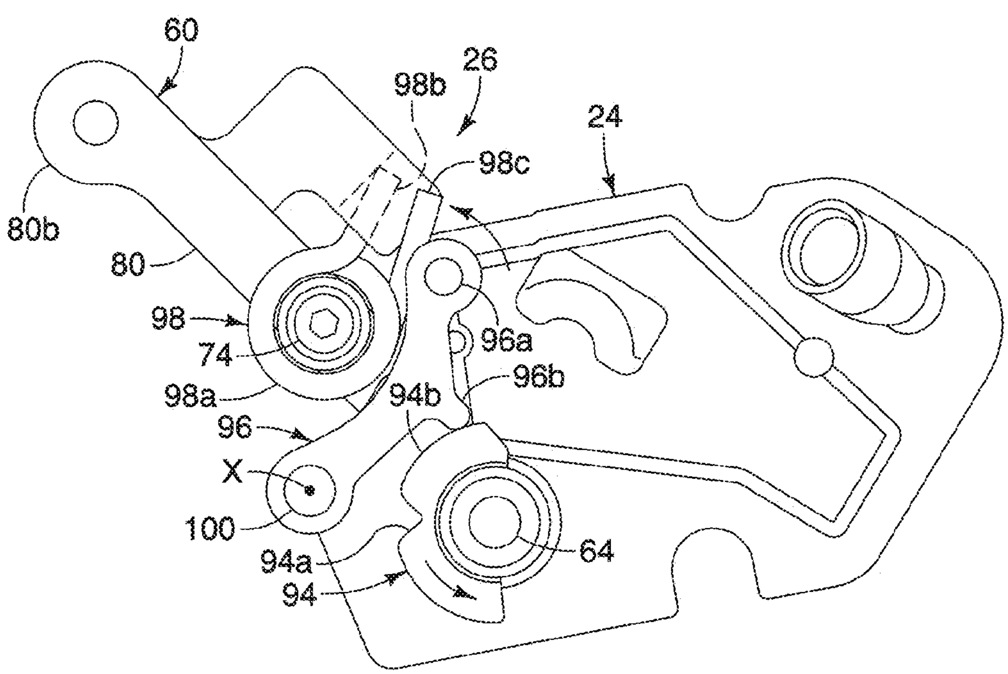
X
100
94
64

FIG. 15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26
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94b
96b
96
X
100
94a
94
64

FIG. 16

BICYCLE REAR DERAILLEUR

BACKGROUND

1. Field of the Invention

This invention generally relates to a bicycle rear derailleur. More specifically, the present invention relates to a bicycle rear derailleur having a linkage moved by a motor unit.

2. Background Information

A bicycle typically uses a chain drive transmission for transmitting a pedaling force to a rear wheel. The chain drive transmission of a bicycle often uses derailleurs to selectively move a chain from one of a plurality of sprockets to another for changing speeds of the bicycle. A typical derailleur has a base member, a movable member supporting a chain guide and a linkage assembly (e.g., a moving mechanism) coupled between the base member and the movable member so that the chain guide moves laterally relative to the base member. Recently, derailleurs have been equipped with motor units to make shifting gears easier.

SUMMARY

Generally, the present disclosure discloses various features of a bicycle derailleur. In one feature, a bicycle rear derailleur is provided that includes a linkage and a motor unit that provides a compact arrangement.

In view of the state of the known technology, a bicycle rear derailleur is provided that basically comprises a base member, a movable member, a linkage and a motor unit. The base member is configured to be mounted to a bicycle, The movable member is movably coupled to the base member. The linkage includes an outer link pivotally connected to the base member about a first pivot axis and pivotally connected to the movable member about a second pivot axis, and an inner link pivotally connected the base member and the movable member. The motor unit includes an output shaft having a rotational axis being parallel to one of the first pivot axis and the second pivot axis. The output shaft of the motor unit drives the outer link to move the movable member with respect to the base member. The inner link moves in response to movement of the outer link.

Other objects, features, aspects and advantages of the disclosed bicycle rear derailleur will become apparent to those skilled in the art from the following detailed description, which, taken in conjunction with the annexed drawings, discloses one embodiment of the bicycle rear derailleur.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the attached drawings which form a part of this original disclosure:

FIG. **1** is a partial side elevational view of a rear portion of a bicycle with a bicycle rear derailleur in a low operating position;

FIG. **2** is a frame side perspective view of the rear derailleur illustrated in FIG. **1** with the rear derailleur in the low operating position when a chain is not engaged;

FIG. **3** is a partial side elevational view of a rear portion of a bicycle with a rear derailleur in a low operating position when a cover member of the movable member is detached;

FIG. **4** is a cross sectional view of a rear portion of a bicycle with a rear derailleur in a low operating position;

FIG. **5** is a frame side perspective view of selected parts of the rear derailleur of FIGS. **1** and **2** with the rear derailleur in the low operating position;

FIG. **6** is a frame side perspective view of selected parts of the rear derailleur of FIGS. **1** and **2** with the rear derailleur moved from the low operating position of FIG. **5** to an intermediate operating position;

FIG. **7** is a frame side perspective view of the selected parts of the rear derailleur of FIG. **6** with the saver mechanism in a first non-drive transmitting position;

FIG. **8** is a frame side perspective view of the selected parts of the rear derailleur of FIG. **6** with the saver mechanism in a second non-drive transmitting position;

FIG. **9** is a top plan view of selected parts of the rear derailleur of FIGS. **1** and **2** showing the base member supporting the motor unit and the outer link operatively coupled to the motor unit via the saver mechanism;

FIG. **10** is a top plan view of selected parts of the rear derailleur of FIGS. **1** and **2** showing internal components of the motor unit;

FIG. **11** is a frame side perspective view of the selected parts of the rear derailleur of FIGS. **1** and **5** showing the motor unit and the outer link operatively coupled to the motor unit via the saver mechanism;

FIG. **12** is a frame side perspective view of the motor unit, the outer link and the saver mechanism of the rear derailleur of FIGS. **1** and **2**, but with the drive link removed;

FIG. **13** is another frame side view of the motor unit, the outer link and the saver mechanism of the rear derailleur of FIGS. **1** and **2**, but with the drive link removed;

FIG. **14** is a frame side view, similar to FIG. **13**, of the motor unit, the outer link and the saver mechanism of the rear derailleur of FIGS. **1** and **2**, but with outer link moved to the top operating position;

FIG. **15** is a frame side view of the selected parts of the rear derailleur of FIG. **6** with the saver mechanism in the first non-drive transmitting position; and

FIG. **16** is a frame side view of the selected parts of the rear derailleur of FIG. **6** with the saver mechanism in the second non-drive transmitting position.

DETAILED DESCRIPTION OF EMBODIMENTS

Selected embodiments will now be explained with reference to the drawings. It will be apparent to those skilled in the art from this disclosure that the following descriptions of the embodiments are provided for illustration only and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

Referring initially to FIG. **1**, a rear portion of a bicycle **10** is illustrated that includes, among other things, a bicycle rear derailleur **12** in accordance with an illustrated embodiment. The rear derailleur **12** is secured to a rear portion of a bicycle frame **14** in a conventional manner as discussed below. The rear derailleur **12** is operated by an electric rear shifter (not shown), which is a shift actuating device. The electric rear shifter operates the rear derailleur **12** between a plurality of shift stage (gear) positions such that a chain **16** is moved by the rear derailleur **12** in a lateral direction between a plurality of rear sprockets S. The rear derailleur **12** is illustrated in a low shift stage (gear) position in FIG. **1**. As used herein, the term "low shift stage (gear) position" refers to the rear derailleur **12** being in an operating that corresponds to the chain **16** being guided onto the rear sprocket S with the largest number of teeth. As used herein, the term "top shift stage (gear) position" refers to the rear derailleur **112** being in an operating position that corresponds to the chain **16** being guided onto the rear sprocket S with the smallest number of teeth.

The bicycle rear derailleur **12** basically includes a base member **18**, a movable member **20** and a linkage **22**. A motor unit **24** is operatively coupled to the linkage **22** to move the movable member **20** with respect to the base member **18**. Thus, in the illustrated embodiment, the rear derailleur **12** constitutes an electric or motorized rear derailleur. A saver mechanism **26** operatively couples the motor unit **24** to the linkage **22** to provide protection for the motor unit **24** as discussed below.

In the illustrated embodiment, the base member **18** includes a first bracket member **28**, a second bracket member **30** and a bracket axle unit **32**. The first and second bracket members **28** and **30** are preferably constructed of a hard rigid material such as a lightweight metal (e.g., an aluminum alloy). The first and second bracket members **28** and **30** are fixed together by a pair of bolts **34**. The motor unit **24** is supported between the first and second bracket members **28** and **30** with one of the bolts **34** passing through the motor unit **24** to secure the motor unit **24** to the base member **18**. As seen in FIG. **2**, the first bracket member **28** also includes a low shift stage adjustment screw **36***a* and a top shift stage adjustment screw **36***b* for setting range of movement of the movable member **20** with respect to the base member **18**. The bracket axle unit **32** is attached to the first bracket member **28** by a bolt **38**. The bracket axle unit **32** includes a fixing bolt **40**. The fixing bolt **40** is threaded into a threaded hole of the bicycle frame **14**. Thus, the base member **118** is configured to be mounted to the bicycle **10** by the fixing bolt **40**.

As seen in FIGS. **1** to **3**, the movable member **20** is movably coupled to the base member **18** by the linkage **22**. The movable member **20** includes a chain guide **42** pivotally coupled to the movable member **20** by an axle **44** to pivot about a chain guide pivot axis P, which is sometimes called the P-axis of the rear derailleur. The axle **44** is made of several pieces (not shown) to aid in the assembly of the movable member **20** and the attachment of the chain guide **42** to the movable member **20**.

As best seen in FIGS. **2** and **3**, the chain guide **42** basically includes a pair of chain cage plates **46**, a tension pulley **48** and the guide pulley **50** rotatably disposed between the chain cage plates **46**. In the illustrated embodiment, the guide pulley **50** is rotatably disposed on the axle **44**, while the chain guide **42** is non-rotatably mounted to the axle **44**. As seen in FIG. **4**, a biasing element **52** is provided between the movable member **20** and the chain guide **42** to bias the chain guide **42** around the chain guide pivot axis P in a first rotational direction D**1**. Thus, the first rotational direction D**1** is a clockwise rotational direction of the chain guide **42** around the chain guide pivot axis P while being viewed along the chain guide pivot axis P from the non-frame facing side of the movable member **20**. In this illustrated embodiment, the biasing element **52** is a torsion spring having a coiled portion disposed around the axle **44**, a first spring end engaged with the movable member **20** and a second spring end engaged with the chain guide **42**.

In the illustrated embodiment, the movable member **20** is provided with a friction element **54** operatively arranged between the movable member **20** and the chain guide **42** to frictionally provide rotational resistance in a second rotational direction D**2** of the chain guide **42** about the chain guide pivot axis P. Preferably, friction element **54** is adjustable to vary the rotational resistance provided by the friction element **54**. Basically, the friction element **54** increases an operation energy of the motor unit **24** as the motor unit **24** moves the movable member **20** toward the low shift stage position with respect to the base member **18**. The friction element **54** constitutes a resistance applying element. In this illustrated embodiment, a one-way clutch **56** is disposed between the friction element **54** and the axle **44**. The friction element **54** applies resistance to the rotational movement of the chain guide **42** in the second rotational direction D**2** with respect to the movable member **20**. In particular, the friction element **54** applies frictional resistance to rotational movement of the chain guide **42** by applying frictional resistance to the rotation of one-way clutch **56**. Since resistance applying elements and one-way clutches similar to the friction element **54** and the one-way clutch **56** are discussed in detail in U.S. Patent Application Publication No. 2012/0083371, the friction element **54** and the one-way clutch **56** will not be discussed in further detail herein.

The linkage **22** operatively connects the movable member **20** to the base member **18**. In the illustrated embodiment, the linkage **22** includes a first or outer link **60** and a second or inner link **62**. The outer link **60** is pivotally connected to the base member **18** by an output shaft **64** of the motor unit **24** about a first pivot axis A**1**. The outer link **60** is pivotally connected to the movable member **20** by a pivot pin **66** about a second pivot axis A**2**. The inner link **62** is pivotally connected the base member **18** by a pivot pin **68** about a third pivot axis A**3** and the movable member **20** by a pivot pin **70** about a fourth pivot axis A**4**. Thus, the outer and inner links **60** and **62** have first ends pivotally connected to the base member **18** and second ends pivotally connected to the movable member **20** to define a four bar linkage arrangement.

As seen in FIG. **2**, the linkage **22** further includes a biasing member **72** that is interposed between the outer and inner links **60** and **62** to bias the movable member **20** towards one of a low shift stage position and a top shift stage position. In the illustrated embodiment, the biasing member **72** is a coil tension spring that biases the movable member **20** towards the low shift stage position. In particular, the biasing member **72** has a first end **72***a* connected to the outer link **60** by a first mounting element **74** (e.g., a screw as shown, a press-fitted pin or other suitable mounting element) and a second end **72***b* connected to the inner link **62** by a second mounting element **76** (e.g., a screw as shown, a press-fitted pin or other suitable mounting element), With this arrangement, the biasing member **72** is stretched as the movable member **20** moves from the low shift stage position to the top shift stage position. In the low shift stage position, the biasing member **72** is preloaded (slightly stretched) so that the outer link **60** contacts a tip of a low shift stage adjustment screw **36***a* as seen in FIG. **2**.

The biasing member **72** aids in taking up play or clearance between the gears of the motor unit **24** and other manufacturing tolerances in the manufacture of the rear derailleur **12**. As a result, when the motor unit **24** is operated in a first rotational amount from a first position to a second position, and then the motor unit **24** is subsequently operated in a second rotational amount from the second position to the first position, the first and second rotational amounts may become slightly different position if the biasing member **72** is not provided to bias the movable member **22** in one direction. Thus, the biasing member **72** improves the stability of the shift positions of the rear derailleur **12**.

In the illustrated embodiment, the outer link **60** includes a first linking member **80** and a second linking member **82**, but the outer link **60** may be made by a single piece, if needed and/or desired. A first end **80***a* of the first linking member **80** is pivotally connected to the base member **18** by a first end of the output shaft **64** of the motor unit **24** about the first pivot axis A**1**. Specifically, the first end **80***a* of the first linking member **80** is not fixed to the output shaft **64**, but rather the output shaft **64** can rotate relative to the first end **80***a* of the first linking member **80**. The second linking member **82** is rotatably mounted on a second end of the output shaft **64** of the motor unit **24**. When assembling the rear derailleur **12**, it is easy to attach the outer link **60** to the output shaft **64** of the motor unit **24** as pivot shaft of the outer link **60** because the outer link **60** constructed by a plural parts. A second end **80***b* of the first linking member **80** is pivotally connected to the movable member **2.0** by the pivot pin **66** about the second pivot axis A**2**. A first end **82***a* of the second linking member **82** is pivotally connected to the base member **18** by the output shaft **64** of the motor unit **24** about the first pivot axis A**1**. Specifically, the first end **82***a* of the second linking member **82** is not fixed to the output shaft **64**, but rather the output shaft **64** can rotate relative to the first end **82***a* of the second linking member **82**. A second end **82***b* of the second linking member **82** is fixedly attached to an intermediate portion **80***c* of the first linking member **80** by the mounting element **74**.

Now the motor unit **24** will be discussed in more detail. The motor unit **24** includes a motor **84**, a gear reduction unit **86** and a shift stage position sensor **88**. The motor **84**, the gear reduction unit **86** and the shift stage position sensor **88** are disposed inside a motor housing **90** that is supported on the base member **18**. The motor **84** is a reversible electric motor. Rotation of the output shaft **64** in one direction moves the movable member **20** and the chain guide **42** toward a low shift stage position with respect to the base member **18**, and that rotation of the output shaft **64** in the other direction moves the movable member **20** and the chain guide **42** toward a top shift stage position with respect to the base member **18**. The output shaft **64** of the motor unit **24** is connected to an output shaft **84***a* of the motor **84** by the gear reduction unit **86**. The output shaft **64** of the motor unit **24** is connected the outer link **60** by the saver mechanism **26** as discussed below. In the illustrated embodiment, the shift stage position sensor **88** is a digital position sensor that this mounted on the gear reduction unit **86** to detect movement of one of the parts of the gear reduction unit **86**. More particularly, the shift stage position sensor **88** of the illustrated embodiment is formed by a position sensor shutter wheel and a dual channel photo interrupter having a light source or LED that is disposed on one side of the shutter wheel and a phototransistor (e.g., a light detector) disposed on the other side of the shutter wheel.

The output shaft **64** of the motor unit **24** is rotatably mounted to within motor housing **90** to project out of opposite ends of the motor housing **90** to pivotally support the outer link **60** on the base member **18**. The output shaft **64** of the motor unit **24** has a rotational axis R that is parallel to the first pivot axis A**1** and the second pivot axis A**2**. In this embodiment, the rotational axis R is also parallel to the third pivot axis A**3** and the fourth pivot axis A**4**. The rotational axis R of the output shaft **64** and the first pivot axis A**1** are coaxial in the illustrated embodiment. The output shaft **64** of the motor unit **24** drives the outer link **60** to move the movable member **20** with respect to the base member **18**. The inner link **62** moves in response to movement of the outer link **60**. Basically, a movement force of the output shaft **64** of the motor unit **24** is transmitted to the outer link **60** at the intermediate portion **80***c*, which is located between the first and second pivot axes A**1** and A**2** of the outer link **60** by the saver mechanism **26**.

Now the saver mechanism **26** will be discussed in more detail with reference to FIGS. **12** to **16**. The saver mechanism **26** includes an output member **94**, a drive link **96** and a biasing element **98**. The saver mechanism **26** basically performs two functions. First, the saver mechanism **26** normally transmits a drive force of the motor **84** to the outer link **60** for moving the movable member **20** with respect to the base member **18**. Second, the saver mechanism **26** stops the transmission of a drive force of the motor **84** to the outer link **60** such that the motor unit **84** can continue to operate even though the movable member **20** will not move with respect to the base member **18** (e.g. becomes jammed), or the force to move the movable member **20** with respect to the base member **18** becomes greater than a prescribed operating force. In this way, the motor unit **84** is protected by the saver mechanism **26** in certain situations.

As seen in FIGS. **15** to **16**, the output member **94** is movably operated by the motor **84** of the motor unit **24**. In particular, the output member **94** is fixed on the output shaft **64** of the motor unit **24** to rotate with the output shaft **64**. For example, the output member **94** is fixed to the output shaft **64** of the motor unit **24** by a spline connection as illustrated. In this way, the output member **94** is turned as the output shaft **64** of the motor unit **24** is turned by the operation of the motor **84**. The movement force (i.e., torque) of the output member **94** is transmitted by the drive link **96** to the outer link **60** at the intermediate portion **80***c* of the first linking member **80**, which is located between the first and second pivot axes A**1** and A**2** of the outer link **60**. More specifically, the drive link **96** is movably mounted on the outer link **60** between a drive transmitting position that connects a drive force of the motor **84** to the outer link **60** and a non-drive transmitting position that disconnect the drive force of the motor **84** from the outer link **60**. The biasing element **98** applies a biasing force on the drive link **96** to bias the drive link **96** into contact with the output member **94**. The drive link **96** engages the output member **94** to move together while the drive link **96** is in the drive transmitting position. On the other hand, the drive link **96** disengages from the output member **94** to provide relative movement between the drive link **96** and the output member **94** while the drive link **96** is in the non-drive transmitting position. The drive link **96** moves from the drive transmitting position to the non-drive transmitting position upon a prescribed resistance occurring in the outer link **60**, which overcomes the biasing force of the biasing element **98** on the drive link **96**.

As seen in FIGS. **15** to **16**, the biasing element **98** applies a biasing force on the drive link **96** to bias the drive link **96** into engagement with the output member **94**. Thus, the output shaft **64** of the motor unit **24** is linked to the outer link **60** by the output member **94** and the drive link **96** as a result of the biasing element **98** such that the drive force of the motor **84** is transmitted to the outer link **60** for moving the movable member **20** with respect to the base member **18**. The biasing element **98** applies a biasing force on the drive link **96** into engagement with the output member **94** to maintain the drive link **96** in the drive transmitting position. Thus, this arrangement of the output member **94**, the drive link **96** and the biasing element **98** for provides an overridable connection between the output shaft **64** of the motor unit **24** and the outer link **60** in which the connection between the output shaft **64** of the motor unit **24** and the outer link **60** is switched from the drive transmitting position to the non-drive transmitting position upon the force required to move the movable member **20** with respect to the base member **18** becoming greater than a prescribed operating force.

More specifically, in the illustrated embodiment, the drive link **96** is pivotally mounted to the second linking member **82** by a pivot pin **100** that defines a pivot axis X. The drive link. **96** includes a contact portion **96***a* that receives the biasing force of the biasing element **98** and an output engagement portion **96***b* that engages the output member **94** to establish the drive transmitting position. The output engagement portion **96***b* is located between the contact portion **96***a* and the pivot axis X where the drive link **96** is pivotally mounted on the second linking member **82**. In the illustrated embodiment, the overridable connection between the output shaft **64** of the motor unit **24** and the outer link **60** is established by providing one of the output engagement portion **96***b* and the output member **94** with a notch and the other of the output engagement portion **96***b* and the output member **94** with a protrusion that mates with the notch to establish the drive transmitting position. For example, as illustrated, the output member **94** includes a notch **94***a* and the output engagement portion **96***b* is a protrusion that mates with the notch **94***a* to establish the drive transmitting position.

In the illustrated embodiment, the biasing element **98** is a coil spring that is mounted on the mounting element **74** that attaches the second linking member **82** to the first linking member **80**. In particular, the biasing element **98** has a coil portion **98***a* disposed on the mounting element **74**, a first end portion **98***b* contacting the first linking member **80** and a second end portion **98***c* contacting the drive link **96**. As mentioned above, one end of the biasing member **72** is also connected to the mounting element **74**. Thus, the mounting element **74** performs several functions to provide a compact arrangement with a minimal number of parts.

FIGS. **7**, **8**, **15** and **16** illustrate situations in which the movable member **20** will not move with respect to the base member **18** (e.g. becomes jammed), or for some reason the force to move the movable member **20** with respect to the base member **18** becomes greater than a prescribed operating force, which is determined by the biasing force of the biasing element **98**. If the movable member **20** becomes stuck, and the output shaft **64** of the motor unit **2.4** is driven by the motor **84**, the saver mechanism **26** will permit the output shaft **64** of the motor unit **24** to rotate. In particular, the output member **94** will act as a cam that moves the drive link **96** against the biasing force of the biasing element **98**. This movement of the drive link **96** by the output member **94** against the biasing force of the biasing element **98** results in the output engagement portion **96***b* (e.g., protrusion) of the drive link **96** being forced out of the notch **94***a* of the output member **94** and onto a cam surface **94***b* of the output member **94**. Once the output engagement portion **96***b* is resting on the cam surface **94***b*, the output shaft **64** of the motor unit **24** can rotate without transmitting the drive force to the outer link **60**. The cam surface **94***b* of the output member **94** extends in both circumferential directions from the notch **94***a* of the output member **94**. in this way, the motor **84** is protected in both operating directions.

The term "connect" or "connected", as used herein, encompasses configurations in which an element is directly secured to another element by affixing the element directly to the other element; configurations in which the element is indirectly secured to the other element by affixing the element to intermediate member(s) which in turn are affixed to the other element; and configurations in which one element is integral with another element, i.e. one element is unitary part of the other element. For example, the magnetized part can be directly secured to the crank arm attachment part, or can be indirectly secured to the crank arm attachment part through intermediate member(s), or can be integral with the crank arm. attachment part. This definition also applies to words of similar meaning, for example, the terms "attach", "attached", "join", "joined", "fix", "fixed", "bond", "bonded", "couple", "coupled " and their derivatives.

While only selected embodiments have been chosen to illustrate the present invention, it will be apparent to those skilled in the art from this disclosure that various changes and modifications can be made herein without departing from the scope of the invention as defined in the appended claims. For example, the size, shape, location or orientation of the various components can be changed as needed and/or desired so long as they do not substantially their intended function. Components that are shown directly connected or contacting each other can have intermediate structures disposed between them unless specifically stated otherwise. The functions of one element can be performed by two, and vice versa unless specifically stated otherwise. The structures and functions of one embodiment can be adopted in another embodiment. It is not necessary for all advantages to be present in a particular embodiment at the same time. Every feature which is unique from the prior art, alone or in combination with other features, also should be considered a separate description of further inventions by the applicant, including the structural and/or functional concepts embodied by such feature(s). Thus, the foregoing descriptions of the embodiments according to the present invention are provided for illustration only, and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

What is claimed is:

1. A bicycle rear derailleur comprising:

abuse member configured to be mounted to a bicycle frame, the base member having a frame facing side and a non-frame facing side;

a movable member movably coupled to the base member;

a linkage including an outer link pivotally connected to the base member about a first pivot axis and pivotally connected to the movable member about a second pivot axis, and an inner link pivotally connected the base member about a third pivot axis and the movable member about a fourth pivot axis, the first, second, third and fourth pivot axes being offset from each other, the outer link overlying the inner link as viewed from a direction facing the frame facing side of the base member; and

a motor unit including an output shaft having a rotational axis being parallel to at least one of the first pivot axis and the second pivot axis, the output shaft of the motor unit being configured to pivotally support the outer link, the output shaft of the motor unit driving the outer link such that a motor force is transmitted from the outer link to the inner link to move the movable member with respect to the base member, the inner link moving in response to movement of the outer link.

2. The bicycle rear derailleur according to claim **1**, wherein a movement force of the output shaft of the motor unit is transmitted at a portion of the outer link located between the first and second pivot axes of the outer link.

3. The bicycle rear derailleur according to claim **1**, wherein the rotational axis of the output shaft and the first pivot axis are coaxial.

4. The bicycle rear derailleur according to claim **1**, wherein the linkage includes a biasing member interposed between the inner link and the outer link to bias the movable member to one of a low shift stage position and a top shift stage position.

5. The bicycle rear derailleur according to claim **1**, further comprising

a saver mechanism is operatively coupled between the output shaft of the motor unit and the outer link.

6. The bicycle rear derailleur according to claim **5**, wherein the outer link includes a first linking member pivotally connected to the movable member, and a second linking member pivotally connected to the base member and being attached to the first linking member; and

the saver mechanism includes an output member movably operated by the motor unit, a drive link movably mounted on the outer link between a drive transmitting position that connects a drive force of the motor to the outer link and a non-drive transmitting position that disconnect the drive force of the motor from the outer link, and a biasing element applying a biasing force on the drive link into engagement with the output member to maintain the drive link in the drive transmitting position.

7. The bicycle rear derailleur according to claim **6**, wherein the biasing element is mounted on a mounting element that attaches the second linking member to the first linking member.

8. The bicycle rear derailleur according to claim **7**, further comprising

a biasing member having a first end connected to the mounting element and a second end connected to the inner link.

9. The bicycle rear derailleur according to claim **7**, wherein the biasing element is a coil spring having a coil portion disposed on the mounting element and a first end portion contacting the first linking member and a second end portion contacting the drive link.

10. The bicycle rear derailleur according to claim **6**, wherein

the drive link is pivotally mounted on the second linking member.

11. The bicycle rear derailleur according to claim **6**, wherein

the second linking member is rotatably mounted on the output shaft of the motor unit.

12. The bicycle rear derailleur according to claim **11**, wherein

the output member is fixed on the output shaft of the motor unit to rotate with the output shaft.

13. The bicycle rear derailleur according to claim **1**, further comprising

a chain guide pivotally coupled to the movable member about a chain guide pivot axis; and

a friction element operatively arranged between the movable member and the chain guide to frictionally provide rotational resistance in a first rotational direction of the chain guide about the chain guide pivot axis.

14. A bicycle rear derailleur comprising:

a base member configured to be mounted to a bicycle;

a movable member movably coupled to the base member;

a linkage including an outer link pivotally connected to the base member about a first pivot axis and pivotally connected to the movable member about a second pivot axis, and an inner link pivotally connected the base member about a third pivot axis and the movable member about a fourth pivot axis, the first, second, and third pivot axes being offset from each other;

a motor unit including an output shaft having a rotational axis being parallel to at least one of the first pivot axis and the second pivot axis, the output shaft of the motor unit being configured to pivotally support the outer link, the output shaft of the motor unit driving the outer link to move the movable member with respect to the base member such that a motor force is transmitted from the outer link to the inner link, the inner link moving in response to movement of the outer link;

a drive link pivotally mounted on an axis offset from the rotational axis of the output shaft; and

a biasing element interposed between the outer link and the drive link to apply a biasing force on the drive link.

15. A bicycle rear derailleur comprising:

a base member configured to be mounted to a bicycle;

a movable member movably coupled to the base member;

a linkage including an outer link pivotally connected to the base member about a first pivot axis and pivotally connected to the movable member about a second pivot axis, and an inner link pivotally connected the base member about a third pivot axis and the movable member about a fourth pivot axis, the first, second, third and fourth pivot axes being offset from each other; and

a motor unit including an output shaft having a rotational axis being parallel to at least one of the first pivot axis and the second pivot axis, the outer link being fixed to the output shaft of the motor unit, the output shaft of the motor unit being configured to pivotally support the outer link, the output shaft driving the outer link to move the movable member with respect to the base member such that a motor force is transmitted from the outer link to the inner link, the inner link moving in response to movement of the outer link.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,303,763 B2
APPLICATION NO. : 13/709382
DATED : April 5, 2016
INVENTOR(S) : Yamaguchi et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the claims

Column 8, Line 19, Claim 1, delete "abuse member configured to be" and insert --a base member configured to be--

Signed and Sealed this
Fourth Day of October, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office